

BRITISH MEDICAL JOURNAL

LONDON SATURDAY DECEMBER 25 1954

HOW MEDICINE BECAME ANATOMICAL*

BY

CHARLES SINGER, D.M., D.Litt., D.Sc., F.R.C.P.

Emeritus Professor of History of Medicine, University of London;

Co-editor of "A History of Technology"

For the last 400 years every medical man has been trained to regard an accurate knowledge of the structure of the human body as the very foundation of his art. This attitude is now so general that we treat it as self-evident. Nevertheless the idea was at one time revolutionary, and its modern acceptance is due to certain reformers of the sixteenth century, and especially to Vesalius. But even since his time, as also in many earlier centuries, there have been highly scientific observers of disease whose work has been quite independent of anatomy. Such were the Hippocratic physicians of the fifth and fourth centuries B.C., several of the Arabic writers, and notably Rhazes (A.D. 852-932) who first described measles, the founders of modern epidemiology, Baillou (1538-1613) and Sydenham (1624-89), and the great schools of medical statisticians of the nineteenth and twentieth centuries. In our own times whole regions of medical thought, such as those of demography and psychological medicine, are developing without any clear anatomical background.

Most teachers would probably now agree that the medical curriculum is overweighted on the purely anatomical side and that the time for lightening the load has arrived. Nevertheless there is no likelihood that anatomy will lose its place as the basic, positive discipline of our art. The processes which have determined the modern status of anatomy make a very long and exceedingly complex story, extending over some two and a half millennia, touching and combining with various cultural streams at many points. Here it will not be possible to do more than glance at a few of the more important incidents in this long story.

Folk Attitude to Necropsy

All know of the popular resistance to post-mortem examination and of the general fear and disgust aroused by a dead body. What is the origin of all this? "Religion," some would answer. Surely no. The objection is more ancient than anything that can reasonably be called religion. That word, if it is to have any meaning at all, must be related to some coherent view of man's place in the universe. The very beasts, who can have no anticipation of death, no understanding of its nature, and certainly no religion, flee from the dead body of a comrade. Among human beings there are still many tribes who are quite unaware that death is the inevitable end of life and regard every such event as something unnatural, brought about by the attack of malign beings. Many peoples of lowly culture, still in

the hunting, food-gathering, or early agricultural stages, habitually abandon a hut or even a village where a death has occurred. They prefer rebuilding to living within reach of unfriendly spirits.

The belief that the dead exercise an evil influence on the living, and must therefore be propitiated, is as universal as the belief in ghosts. This attitude is found in all those cultural stages that precede the differentiation of religion, in the proper sense, and long survives its development. Such a view, whether held consciously, or half-consciously, or unconsciously as a folk-memory, naturally opposes investigation of the structure of the human body. Post-mortem examination and, still more, dissection are disrespectful to the dead. This is wholly irrational and can be made to fit no rational conception of life from either a spiritual or a materialist point of view. But which of us has not met it in seeking to obtain permission for a necropsy?

A Great Contribution to Science

The scientific investigation of the human body is not very ancient. It was introduced at a fairly definite date and under distinctive philosophical influences. Dissection was not practised by any people before the Greeks. It is one of their great scientific contributions. When, where, and under what circumstances did it arise? The first two of these questions can be answered with considerable exactness. Dissection of the human body was first practised systematically in public about 300 B.C., or possibly a few years earlier, and it began effectively at Alexandria. What is more debatable is the intellectual atmosphere that made this change of attitude possible among the Alexandrian Greeks.

The pre-Alexandrian Greek attitude towards a direct investigation of the structure of the human body can be gleaned from the earliest documents of the so-called *Hippocratic Collection*. This is a large mass of writings of various dates. It must be understood that there is no real evidence that any one of these texts is by Hippocrates, though several are of his period—that is, of somewhere between 450 and 350 B.C. It is these earlier members of the "Collection" which alone interest us here. They discuss clinical conditions on a sound observational basis but exhibit only the simplest theories of disease. They show no tendency to elaborate such conceptions or to locate disease in special organs. They regard disturbance of health as due to the behaviour of certain fluids or humours of which the body is composed. Diseases result from excess, defect, obstruction, or perversion of one or more of these four humours. Since

*Being the substance of the Lloyd Roberts Lecture delivered at the Medical Society of London on September 30, 1954.

diseases are not discussed with reference to local origin, they are not treated as related to the structure of the body. Why, therefore, should the "Hippocratic" physician study anatomy? He did not.

But throughout the *Hippocratic Collection* diseases are sharply distinguished from lesions, such as fractures and dislocations, which are unmistakably related to bodily structures. This differentiation is itself an advance, for in earlier cultural stages diseases were regarded as themselves injuries inflicted by malign beings. The reader may be reminded that the German word for lumbago is, to this day, *Hexenschuss*, "witch-shot." We ourselves still speak of an "attack" of a disease, of a "seizure," or of being "struck down" by some condition. We still recognize a clinical entity

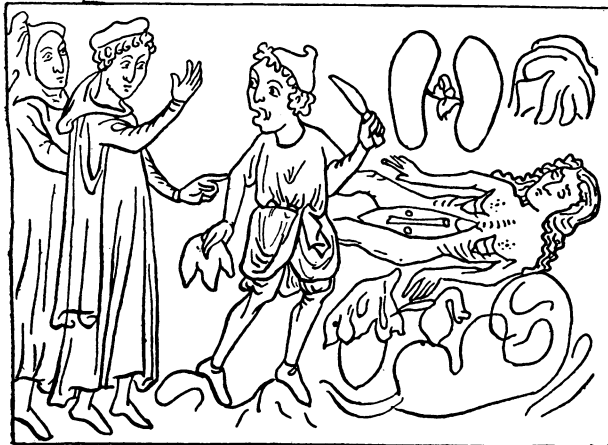


FIG. 1.—Post-mortem scene from a MS. of about 1300 in the Bodleian. The figure with hand raised is a physician. Behind him stands a monk. The operation is performed by an assistant.

called "the plague," which word is nothing but the Latin *plaga*, a blow. None of these terms is very far from the "witch-shot" of the Anglo-Saxon leeches.

It is in connexion with the investigation of fractures and dislocations by the "Hippocratic" physicians that we meet the first traces of real anatomical knowledge. This, in the *Hippocratic Collection*, is seen especially in certain accounts of injuries to the shoulder, hip, and jaw, of about 400 B.C. or perhaps a little later. In the treatment of these injuries, the "Hippocratic" physicians were manifestly more competent than the Egyptian physicians, to whom, alone among their predecessors and contemporaries, we are able to compare them. They were more competent because they possessed some real anatomical knowledge, yet it was still not obtained by any systematic anatomical investigation.

The Greeks of the fifth and fourth centuries B.C., "the Hippocratic age," had a fear of the dead, like all ancient peoples. Moreover, they attached great importance to the proper burial of bodies, even those of enemies. Without decent burial the early Greeks thought that the dead would not only find no rest but would give none to the living. Yet, despite all this, there is some evidence that a small amount of superficial dissection had occasionally been performed by some daring Greek physicians. An examination of passages in the "Hippocratic" works on fractures and joints, especially those on the shoulder-joint, suggest that the author at some time had seen these parts laid bare. He had certainly a fairly detailed knowledge of the bones involved and a clear conception of the mechanics of the joint.

Fear of Dead Bodies

How could this be? How could a Greek of the fourth century B.C. ever examine the structure of a dead body, even to this small extent? There is evidence of a change of attitude to the dead body among the Greeks of that time in the *Dialogues* of Plato (427–347 B.C.). A good example is in the *Phaedo*, which was written somewhat before 367 B.C. In it Socrates (died 399 B.C.), after having discussed the immortality of souls, and having been asked by Crito how he wished to be buried, is represented as replying:

"In any way you please, but take care that I do not get away from you." And then he turned to us and, laughing gently, added, 'I cannot persuade friend Crito that I will be the same Socrates who is now conversing. He thinks I am another Socrates whom he will soon see as a dead body, and he asks, forsooth, "How shall he bury me?" And this, though I have been saying at great length that when I have drunk the poison I shall leave you, and go to the joys of the blessed. Yet he seems to think this mere talk, uttered to comfort you. Therefore I want you to be surety for him, as at the trial he was for me, that when I die I shall but go away, so that Crito may not be grieved when he sees my body ill-used. I would not have him troubled by thinking my lot an evil one or say at the funeral that he is burying Socrates.' (Abbreviated.)

Here is an attempt to overcome the fear of dead bodies on the basis of a rational hypothesis. This is the conception of the soul as an essential but separable element of life. It is not our purpose to discuss here the evolution of the doctrine of the soul, but it is clear enough that we are here presented with a view which, if accepted, would bring such fears into contempt among rational men and relegate them to the class of mere superstitions. And it is noteworthy that among the scores of items in the *Hippocratic Collection*, though they are separated from each other by several centuries, though they exhibit different attitudes to observation, though they have diverse moral outlooks, and though they belong to quite distinct schools of thought, yet there is in them no word of such superstition. Here, at least, the Wisdom of Socrates is justified of her children.

A New Attitude

Aristotle, Plato's pupil, held a modified form of his master's view on the soul. By the time of the death of Aristotle in 322 B.C. there had arisen a new attitude towards life and death among thinking Greeks. And soon after—about 300 B.C.—there was founded the great medical school of antiquity, that of Alexandria. The Greek physicians who gathered there had access to the works of Plato and Aristotle. They approached their task in a climate of opinion on the nature of the human body profoundly different from that of any of the "Hippocratic" age. With Alexandria we begin to hear of open dissection of the human body.

It is unnecessary here to detail the history of the Alexandrian medical school, but it is well to consider certain of the contrasts to our own outlook that it presented. Firstly, there was the extreme smallness of the public to which the ancient scientific writings appealed. Treatises that would now be accessible to students in tens of thousands reached then only a handful. Secondly, the number of learned centres was minute against those in our world or even in the mediaeval world. Some little dissection came to be sporadically practised at Smyrna, Corinth, Pergamum, and a few other centres, but Alexandria was the only effective anatomical centre. Were the civilization of Britain, or of France, or of the United States, or of Russia, or of them all, to be destroyed, a reconstruction of modern science would be possible because the scientific spirit and scientific writings are to be found in many centres all over the world. Not so in antiquity. Obliterate Alexandria and you would have destroyed its characteristic contribution to medicine—namely, human anatomy. And for

effective purposes Alexandria was obliterated on the death of its last Greek ruler, Cleopatra, in 30 B.C., when Egypt became a Roman province.

Influence of Rome

After that event human dissection continued in a few subsidiary centres for a generation or two. It had, however, quite ceased as an open practice both at Alexandria and elsewhere before A.D. 150. Despite the loss of the Alexandrian anatomical works, the names of the most important Greek exponents of the art there and elsewhere have survived. We can form a fair estimate of their achievements. These do not concern us for the moment, but we must consider certain consequences that flowed from the Romanization of the Greek world in general and of Alexandria in particular.

To a thoughtful man of the time, the spread of Roman power seemed a moral revolution or a spiritual reaction—according to his point of view. Both attitudes can be exemplified from writings of the time. The Romans, as a people, had the greatest respect for the dead and protected bodies by laws enforced with their habitual orderliness and methods of regimentation. But the basic folk-religion of the Romans peopled earth and water and air with innumerable supernatural beings. The Romans were, in this sense, the most superstitious of civilized peoples. The popular religions of the Empire became deeply tinged with thought of this type which the Roman populace eagerly absorbed from Oriental cults. Thus, despite the innumerable conflicts of the Romans with Barbarians in the extension or defence of their Empire, and despite the innumerable corpses of which their troops had systematically to dispose, there is no clear evidence of any exploration of the structure of such a body. Human dissection had ceased to be practicable, nor was its purpose generally understood. Till the end of the second century A.D. a human skeleton could be examined at Alexandria, but human anatomy was no longer seriously studied even there.

Animal Dissection and Experiment

One immediate result of the cessation of human dissection was at first, and in some respects, the opposite of what might be expected. The progress of anatomy at Alexandria from 300 to 30 B.C. had been sufficient to establish the value of the subject for medical practice and the general correspondence of human organs to those of other mammals. Now that human bodies were inaccessible, investigators turned to those of animals. This suggested experiment by vivisection, which was now practised with considerable scientific results. On the basis of such experiments, during the first two centuries of the Christian era, an ingenious, coherent, and quite workable system of physiology was

gradually constructed (Fig. 3). It was easily understood and easily applied, and was a real aid in clinical practice. That it contained errors—what system does not?—did not alter the fact that medicine could profit by it. In this new light, physiological doctrine could be used, and was used, to direct intelligent and scientific modes of diagnosis and treatment. Thus, for example, the general properties of the nerves and of the spinal cord, the distribution of the spinal nerves, and the simple mechanics of muscular action were well explored. The broad conclusions reached were not vastly different from those which we now often apply in the first clinical examination of a patient.

The replacement of human bodies by those of apes and other animals for anatomical purposes was thus not all loss. Moreover, the change had certain other real advantages, especially, oddly enough, to surgery. It is to be remembered that the ancient medical man avoided opening the great cavities of the body. His operations were almost entirely for injuries and wounds. True, he would occasionally, and at extreme need, evacuate an empyema, trephine the skull, or even remove a spleen, but other abdominal, thoracic, or cranial procedures were almost unknown.

In the absence of preservatives and in a hot climate dissection had necessarily to be speedy. The bodies of monkeys, being smaller than those of men and easily procurable fresh and in numbers, had thus considerable advantages. Certain parts of apes closely resemble those of men. Especially is this so with the arm and hand. The differences are here chiefly in the level of division of the great flexor and extensor muscles, features themselves variable in human subjects. A good knowledge of the anatomy of a monkey's arm would be a better guide to such operative procedures as the ancients performed than a hastily acquired superficial

knowledge of the anatomy of the human arm. Thus arose an effective physiology and anatomy based on animal dissection and experiment. It is preserved in certain works of Galen, who died in A.D. 201.

Passing of Ancient Anatomy

Despite Roman domination, or because of the peace imposed by Rome, the second century A.D. was one of brilliant achievement in the whole range of the then existing sciences, and specifically in anatomy. Yet the spirit of investigation ceased with remarkable abruptness at the end of that century, and we have to consider the reasons for this. The main intellectual background of the age was now the Stoic and Epicurean philosophies, both, for different reasons, indifferent if not unfriendly to the experimental method. The forms of oriental Paganism rapidly infiltrating the Empire were antithetic to science. The native Roman outlook was contemptuous to "disinterested"

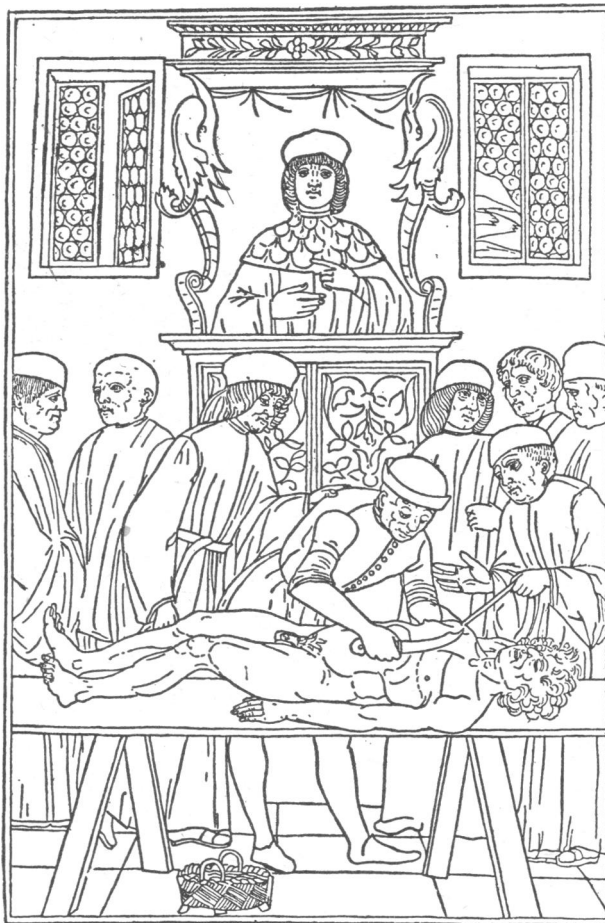


FIG. 2.—Academic "four-day Anatomy" at Bologna, from a book printed at Venice in 1493. The "professor" reads from a book on the desk of his throne-like "chair." The "demonstrator" points out the order of operation with his wand. Doctors and students stand around.

knowledge. The temper of the time was tried and strained by barbarian incursions and ill attuned to patient research. The leaders of the rising sect of the Christians made little direct attack on science, but they certainly despised it. Thus the great syntheses of positive knowledge set out by Galen and Ptolemy in the second half of the second Christian century were not extended in the next age. The public that understood them rightly was rapidly diminishing. Science, in the sense of active conscious investigation, was a process not actively prosecuted again for twelve hundred years.

This funeral oration on ancient anatomy must not be closed without drawing attention to two very striking defects in its method. Firstly, the ancient anatomist did not use,

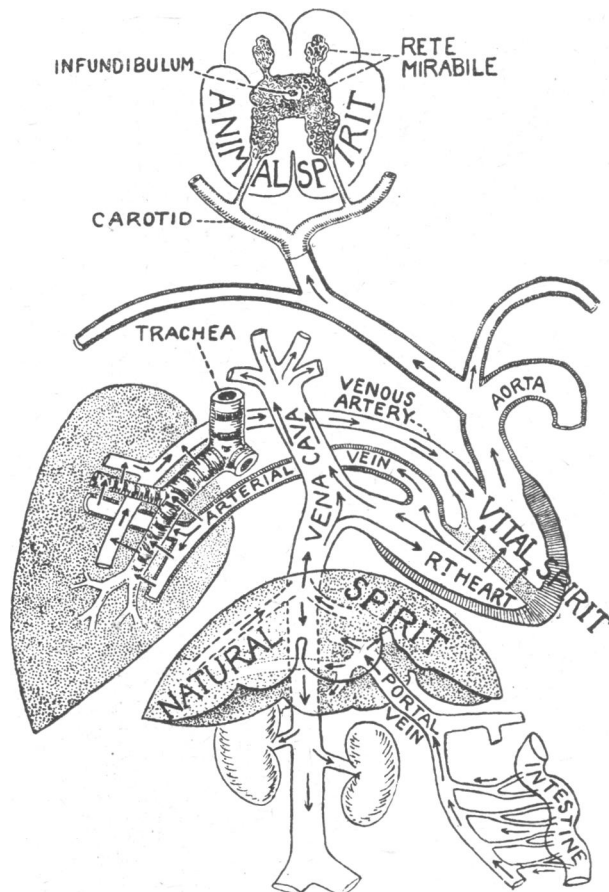


FIG. 3.—Diagram of physiological system according to Galen, based on the three "spirits" and the permeability of the inter-ventricular septum. It is intelligible if the directions of the arrows be followed and it was, in fact, of some use clinically.

and could not use, the graphic method to aid his readers or his hearers in understanding or memorizing what he had to write or say. On occasion anatomical authors did employ semi-mathematical diagrams, comparing certain structures to geometric figures, but, for reasons which will presently emerge, they could go no further. Secondly, anatomical texts in antiquity were always in Greek, a language that had no classical or foreign source on which it could draw for its technical terms, as we ourselves now draw on Greek. Thus, without figures and without a technical vocabulary, the anatomical texts could be neither as clear nor as concise as are ours, nor could they be properly or easily studied apart from the object involved.

It is not necessary to follow here the depressing history of rational medicine in the thirteen centuries that followed A.D. 200. Some memory of the school of Alexandria survived, since, in a travesty of the ancient anatomico-physiological scheme, certain flat and hideous diagrams of the bodily parts, made after the Moslem conquest of Egypt in the seventh century, circulated both East and West. Except for these, our story is almost blank until the eleventh century. Between the eleventh and fourteenth centuries,

however, more authentic, though still very distorted, remains of the ancient anatomical and physiological systems began to be recovered. They trickled back, not in Greek, but as second-, third-, or fourth-hand Latin translations from Arabic, Hebrew, or Syriac abstracts and interpretations of the Greek originals. These provided an impressively verbose body of anatomical and physiological tradition, which was organized into university curricula in the thirteenth, fourteenth, and fifteenth centuries. No single ancient anatomical text was, at this time, even approximately understood.

Some cursory dissection of the human body was introduced early in the fourteenth century in the Italian universities (Fig. 1). The "anatomies" were performed, not for purposes of investigation, but as a mere aid for the memorization of the Arabic-Latin texts. They hardly fulfilled even this purpose, but the practice of an occasional "four-day anatomy" spread to several universities outside Italy (Fig. 2). And so we come to the revival of true anatomy in the fifteenth century.

The Renaissance

In Italy the intellectual atmosphere of the fifteenth century, the "High Renaissance," was determined by many mutually interacting cross-currents, none of which can be completely separated from all the others. Thus, in our field, if anatomy influenced art, surely art equally influenced anatomy. Again, the ancient physiology was revived and better presented than in antiquity itself and came to affect the philosophy of the day, but was certainly affected by that philosophy. Such couplings might be multiplied indefinitely and far beyond the region of our discussion. It was just because of this interdigitation of the regions of intellectual interest that the great figures of Renaissance Italy, such as Alberti, Leonardo, Michelangelo, seem so incredibly versatile. They did not recognize, and they would not even have understood, the fragmentation of knowledge which has become a second nature with us.

Among the welter of interrelated activities that characterized the period, there were four which made a special impact on anatomy. Between them they determined its course and deflected it from being a mere rebirth of the ancient discipline. The four great factors that determined the course of anatomical development all took definitive form within half a century. First was the rise of the science of perspective. Second was the intimately related development of skill in exact representational drawing. Third was the publication of the ancient anatomical texts from which the new anatomy could take its start. Fourth was the perfection of the art of book illustration, so that the anatomist could at last present his findings graphically and acceptably to a wide audience.

Perspective Science and Representational Skill

First, as regards perspective. Artists had always felt the difficulty of representing three-dimensional objects on two-dimensional surfaces. This is the problem of perspective. One way of evading it, freely adopted by ancient artists of many lands, was the use of bas-relief. Another evasion was the adoption of arbitrary rules of representation. The impossible contortions of Egyptian figures, for example, which habitually display the head from the side, the arms and trunk from the front, and the hips and legs again from the side, are the result, as all perspective must be, of the adoption of a convention. All ancient painting and drawing on the flat adopted some device of this sort. All of it, even the best, seems to us to fail when considered from the representational or, as we sometimes call it, the "photographic" point of view. The history of perspective before the great Renaissance artists is complex and does not directly concern us here. It suffices to say that neither the Egyptians, nor the Greeks, nor the Romans, nor the mediaeval peoples of the West, attained any satisfactory solution of the problem, though the search for a solution proceeded through all their histories.

Many conventions of perspective are thus possible, but we now know that there is one, and one only, which can

be called "scientific." Though a convention, it is scientific because, given certain conditions, its truth can, at any time, be demonstrated at will and its accuracy estimated. This convention assumes that vision is monocular and that the position of the observing eye is fixed. Given these conditions the results follow with mathematical certainty. The evolution of this conception was, of course, of high importance for art. Perhaps it is not sufficiently recognized that for science it was among the most fate-fraught discoveries of all time. Without scientific perspective it is impossible adequately to demonstrate the theorems either of mechanics or of solid geometry. Without scientific perspective the development of modern architecture and crystallography, engineering, as well as many of the findings of the biological sciences, and specifically of anatomy, would have been impossible. Perspective is fundamental to modern science.

The method of scientific perspective involves the rule of a single vanishing-point and is sometimes called "Leonardian perspective." Leonardo (1452-1519) was certainly its greatest exponent, but, like most discoveries of the first rank, it was the product of many minds and has an evolutionary history. The largest contributor to its fundamental laws was probably the Italian architect, painter, musician, and poet, L. A. Alberti (1404-72). By the mid-fifteenth century he had worked out the fundamental rules of the subject on an experimental basis.

Before 1470 the young Leonardo was busy practising the new invention with enthusiasm. In the last year or two of the fifteenth century and in the first decade of the sixteenth he was applying it to anatomy. With this new instrument of scientific perspective he was able to represent the detailed structure of the body with a vividness and truth unapproached in any previous age. Certain of the ancient anatomists, and a few even in the later Middle Ages, had a fair idea of some of the organs and systems of the body. What they had not, and what Leonardo was the first to provide and portray, was the idea of the relationships of bodily parts to each other. In this very important sense, Leonardo was the founder of modern anatomy and, with it, of modern physiology. Whatever influence he may have had directly in developing anatomy, it is highly significant that two primal skills, great power in handling perspective and extraordinary facility in drawing, should have been united in this great anatomical pioneer.

Publication of Ancient Anatomical Texts

We turn now to the third basic factor in anatomical development, the recovery of the ancient texts. At the end of the fifteenth century very few of the Greek anatomical works were available, and these only in very inferior translations or versions. By the time that the sixteenth century had run a third of its course, almost the entire corpus of Greek anatomy and physiology, as we know it to-day, had become available in fairly reliable translations, made direct from the original tongue. These translations were first issued mainly by printers at Paris. They had almost completed their task by 1533, when the young Vesalius (1514-64) reached there. Owing to the ineradicable tendency of learning to departmentalize, owing to the endless struggle between letter and spirit, owing to man's weakness for institutions as against their purpose, the very recovery of the ancient anatomical texts, which Leonardo had only just begun to enjoy, now became a foe to the proper development of the subject of which they treated.

During the first third of the sixteenth century, not only were the Greek texts recovered and competently rendered into Latin, but at Paris and Bologna a regular technique of anatomization was systematized. This passed very considerably beyond anything that the Middle Ages had seen. But, except for Leonardo, there were only the most transient attempts, for a whole generation, to apply to anatomy the methods of the new representational art. Its devices were neglected or actively opposed by university professors, who jealously guarded the vested interests of so-called *Humanism*. And at this time, and perhaps still, *Humanism*

was most unfortunately identified with knowledge of ancient texts, of ancient literature, and of ancient thought.

Vesalius, and Modernization of Anatomical Printing

We pass now to the fourth cornerstone of modern anatomy, almost personified in one man. Vesalius was the first who commanded at once a knowledge of those texts, a wide practical experience of anatomy, and the services of artists trained in Leonardian perspective. He had the judgment and power to correlate all these. But, last and not least, his resources enabled him to build on our fourth corner-stone, the art of a great printer and his great wood-cutters. With Vesalius, anatomy therefore became modern at one bound, so far as the printed book was concerned. We have learned very much since his time and he made many mistakes, but in method we are not very far from him.

There are historic figures whose attainments are so outstanding that they are apt to be misrepresented and indeed victimized by hero-worshippers. Leonardo is one such sufferer, Vesalius another. Both had very human weaknesses, and, even allowing for the pioneer character of their work, both made anatomical errors and omissions that are difficult to explain. Some of Leonardo's anatomical omissions are perhaps more understandable in view of his dearth of material. He sometimes erred too, as did Vesalius, by following tradition too faithfully. Yet it is hard to excuse, for example, his division of the human placenta into cotyledons in his noble and moving representation of the child dreaming in its mother's womb. But when Vesalius ascribes to man the great veins of an ungulate, we can only say that he is cribbing from Galen at his worst. Moreover, Vesalius wellnigh missed the importance of relationships in which Leonardo had led the way and also the kindred significance of estimating the relative sizes of adjacent organs. On the latter point he was corrected by his near contemporary, Eustachius (fl. 1520-74), whose worth has been too little considered (Fig. 4).

The anatomical work neither of Leonardo nor of Eustachius was accessible in the sixteenth century. That of Vesalius was, from the first, a prized piece, but there was no room for his vast folio on the ordinary student's desk. Among the earliest general anatomical works suitable for students were the *Institutiones anatomicae* (1611) of the Dane, Caspar Bartholin (1585-1629), which was derived directly from the work of Vesalius, and from him came, in due course, the succession of students' textbooks on anatomy and physiology down to our own day. Thus are the generations bound together.

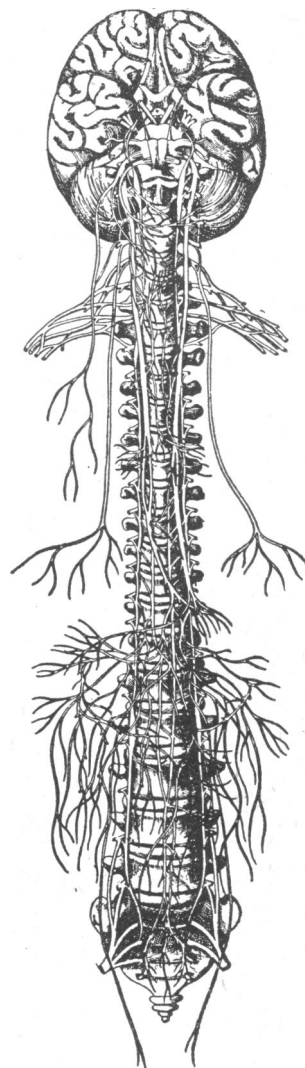


FIG. 4.—Dissection of sympathetic system by Eustachius of about 1570. It was hardly improved until well into the nineteenth century.